Claims

What is claimed is:

1. An apparatus comprising:

a light source to generate light;

a transflective color filter optically coupled to the light source, to receive the light along an incident axis, said transflective color filter including at least one color passband to transmit at least a portion of light within a range of frequencies, and to reflect, along a reflectance axis, at least a portion of light outside of the range of frequencies, with the incident and the reflectance axes being non-coincident; and

a recycling subsystem optically coupled to the transflective color filter, having an input positioned on the reflectance axis and an output, the recycling subsystem to receive the reflected light through the input, and to emit recycled light through the output towards the transflective color filter.

2. The apparatus of claim 1, wherein the transflective color filter is one of a group consisting of a rotating color drum, a rotating spiral color wheel, and a band modulation filter.

3. The apparatus of claim 1, wherein the transflective color filter includes at least one of a group consisting of a red, a green and a blue passband.

4. The apparatus of claim 1, further comprising:

a display optically coupled to the transflective color filter to receive the transmitted light from the transflective color filter.

5. The apparatus of claim 4, wherein the display is a transmissive liquid crystal light valve.

6. The apparatus of claim 4, further comprising:

the display being substantially centered on an optical axis;

a relay optical arrangement, positioned substantially on a first side of the optical axis of the display, to receive the light from the light source and transmit the light, along the incident axis, toward the transflective color filter; and

the input of the recycling subsystem being disposed on a second side of the optical axis of the display.

7. The apparatus of claim 6, further comprising:

a relay lens substantially centered on the optical axis of the display; and

the input of the recycling subsystem and the relay optical arrangement both including sections of the relay lens.

8. The apparatus of claim 6, further comprising:

an optical integrator to receive light from the light source and transmit the light toward an imaging lens, the imaging lens to transmit the light toward the relay optical arrangement.

9. The apparatus of claim 6, wherein the recycling subsystem further comprises

a first mirror to receive a portion of the reflected light from the input of the recycling subsystem and redirect it back towards the input of the recycling subsystem; and

the input of the recycling subsystem being substantially the same as the output of the recycling subsystem.

10. The apparatus of claim 9, wherein the recycling subsystem further comprises:

an optical integrator having a first end to receive the light from the input of the recycling subsystem; and

the first mirror placed on or near a second end of the optical integrator to reflect the light back through the optical integrator towards the first end.

11. The apparatus of claim 10, wherein the recycling subsystem further comprises:

a fold mirror to receive the light from the input of the recycling subsystem and to reflect the light towards an imaging lens, the imaging lens to image the light on the first end of the optical integrator.

12. The apparatus of claim 9, wherein the first mirror is slightly tilted such that the light is redirected back toward the input of the recycling subsystem on a slightly different path.

13. The apparatus of claim 9, further comprising:

a second mirror;

a transflective polarizer, to receive light from the relay optical arrangement, to transmit light in a first polarization state towards the transflective color filter, and to reflect light in a second polarization state towards the second mirror;

the second mirror being adapted to reflect light in the second polarization state back towards the transflective polarizer, resulting in the light reflecting off of the transflective polarizer toward the input of the recycling subsystem; and

a quarter wave plate between the first mirror and the input of the recycling subsystem, to change light in the second polarization state to the first polarization state.

14. The apparatus of claim 13, wherein the quarter wave plate comprises a coating on the first mirror.

15. The apparatus of claim 1, further comprising

a first optical integrator including an input and output aperture, the input aperture to receive light from the light source, and the output aperture to transmit light toward the transflective color filter.

16. The apparatus of claim 15, wherein the recycling subsystem further comprises

a second optical integrator having a first end to receive the reflected light from the transflective color filter.

17. The apparatus of claim 16, wherein the recycling subsystem includes a mirror placed on or near a second end of the second optical integrator to reflect light back through the second optical integrator towards the first end and out towards the transflective color filter.

18. The apparatus of claim 17, wherein the recycling subsystem includes an optical element to image the reflected light from the transflective color filter on the first end of the second optical integrator.

19. The apparatus of claim 15, wherein the output of the recycling subsystem is optically coupled to the first optical integrator.

20. A method comprising:

generating light from a light source;

receiving the light along an incident axis with a transflective color filter, transmitting light within a range of frequencies and reflecting light that is outside of the range of frequencies, along a reflectance axis that is non-coincident with the incident axis; and

recycling the reflected light by reintroducing it to the transflective color filter.

21. The method of claim 20, wherein recycling the reflected light includes integrating the reflected light before reintroducing it to the transflective color filter.

22. The method of claim 20, wherein recycling the reflected light includes reintroducing the light along a recycling axis which is non-coincident with the reflectance axis.

23. The method of claim 22, further comprising

transmitting light of one polarization direction towards the transflective color filter;

reflecting light of a second polarization direction; and

recycling the light of a second polarization direction by changing it to the first polarization direction and transmitting it towards the transflective color filter.

24. The method of claim 22, wherein the recycling axis is substantially coincident with the incident axis.

25. The method of claim 24, further comprising integrating the light travelling along the incident axis.

26. A system comprising:

a video unit with an output video signal; and

a projection system, coupled to video unit, to receive video signal and project video, said projection system comprising

an illumination arrangement including

a light source, to generate light along an incident axis; and

a color recycling subsystem having an input off of the incident axis;

a display optically coupled to the illumination arrangement; and

a projection lens optically coupled to display.

27. The system of claim 26, wherein the illumination arrangement further comprises:

a transflective color filter to receive the light along the incident axis, to transmit light within selected color ranges, and to reflect, along a reflectance axis, light of other color ranges;

the input of the recycling subsystem being positioned on the reflectance axis; and

the recycling subsystem including an output to emit the recycled light towards the transflective scrolling color filter.

28. The system of claim 27 wherein the transflective color filter includes a plurality of color passbands.

29. The system of claim 26, in which the video unit is a selected one of a digital versatile disk (DVD), video camera, and set-top box.

30. The system of claim 26, in which the display comprises a transmissive liquid crystal light valve.